Artículo de investigación

Investigating the Destructive Effect of Earthquake on Urban Landscapes (Case Study: Ahar City)

Investigando el efecto destructivo del terremoto en los paisajes urbanos (Estudio de caso: la ciudad de Ahar)

Investigando o efeito destrutivo do terremoto em paisagens urbanas (estudo de caso: Ahar City)

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Abstract

This research has been conducted to determine the vulnerability of Ahar city spaces due to geographical location and other influential conditions. Using the results of previous researches and presenting combinational components and the modern indexes using the AHP model, this issue has been addressed and, finally, the output of data has been provided. In general, the results of the vulnerability analysis of the spaces of Ahar town indicate that most of the constructed parts of the city are in the moderate vulnerability area; marginal settlements are in the area of high vulnerability and central and historical parts are classified in the area of highly vulnerable zones. However, in the zoning of the whole city's vulnerability, which includes built and arid spaces, the city is placed in the very low vulnerable classification. Accordingly, preventing the unauthorized separation and construction in marginal neighborhoods, the construction of neighborhood parks, the construction and completion of the main road network, the preparing restoration and renovation projects of worn-out and marginal textures, prevention the unauthorized separation outside the legal boundaries of the city, the transformation of abandoned cemeteries into public spaces such as the green space and cultural spaces, wall-laying and channeling of the rivers and river sides and dredging and updating them, are priorities of planning and implementation to rehabilitate the city of Ahar in response to the earthquake.

Resumen

Esta pesquisa foi realizada para determinar a vulnerabilidade dos espaços da cidade de Ahar devido à localização geográfica e outras condições influentes. Usando os resultados de pesquisas anteriores e apresentando componentes combinacionais e os índices modernos usando o modelo AHP, esta questão foi abordada e, finalmente, a saída de dados foi fornecida. Em geral, os resultados da análise de vulnerabilidade dos espaços da cidade de Ahar indicam que a maioria das partes construídas da cidade está na área de vulnerabilidade moderada; assentamentos marginais estão na área de alta vulnerabilidade e partes centrais e históricas são classificadas na área de zonas altamente vulneráveis. No entanto, no zoneamento da vulnerabilidade de toda a cidade, que inclui espaços construídos e áridos, a cidade é colocada na classificação muito baixa e vulnerável. Assim, impedir a separação e construção não autorizadas em bairros marginais, a construção de parques de bairro, a construção e conclusão da rede rodoviária principal, a preparação de projetos de restauração e renovação de texturas desgastadas e marginais, impedir a separação não autorizada fora dos limites legais da cidade, a transformação de cemitérios abandonados em espaços públicos como o espaço verde e espaços culturais, colocação de muro e canalização dos rios e fluviais e dragagem e sua atualização, são prioridades de planejamento e implantação para reabilitar a cidade de Ahar em resposta ao terremoto.

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Keywords: *City Vulnerability, Destruction, Urban Development, Earthquake, Ahar.*

Palavras-chave: Cidade Vulnerabilidade, Destruição, Desenvolvimento Urbano, Terremoto, Ahar.

Resumo

Esta pesquisa foi realizada para determinar a vulnerabilidade dos espaços da cidade de Ahar devido à localização geográfica e outras condições influentes. Usando os resultados de pesquisas anteriores e apresentando componentes combinacionais e os índices modernos usando o modelo AHP, esta questão foi abordada e, finalmente, a saída de dados foi fornecida. Em geral, os resultados da análise de vulnerabilidade dos espaços da cidade de Ahar indicam que a maioria das partes construídas da cidade está na área de vulnerabilidade moderada; assentamentos marginais estão na área de alta vulnerabilidade e partes centrais e históricas são classificadas na área de zonas altamente vulneráveis. No entanto, no zoneamento da vulnerabilidade de toda a cidade, que inclui espaços construídos e áridos, a cidade é colocada na classificação muito baixa e vulnerável. Assim, impedir a separação e construção não autorizadas em bairros marginais, a construção de parques de bairro, a construção e conclusão da rede rodoviária principal, a preparação de projetos de restauração e renovação de texturas desgastadas e marginais, impedir a separação não autorizada fora dos limites legais da cidade, a transformação de cemitérios abandonados em espaços públicos como o espaço verde e espaços culturais, colocação de muro e canalização dos rios e fluviais e dragagem e sua atualização, são prioridades de planejamento e implantação para reabilitar a cidade de Ahar em resposta ao terremoto.

Palavras-chave: Cidade Vulnerabilidade, Destruição, Desenvolvimento Urbano, Terremoto, Ahar.

1. Introduction

1.1. Statement of the Problem

The earthquake is one of the characteristics of our planet, which alone damages and inflicts harms to thousands of lives around the world and generates a lot of financial losses, and because of the extent of the territory and the extent and severity of the damages incurred, it is one of the most recognized natural disasters in the world, this phenomenon is one of the factors that can lead to a crisis. Cities as a gathering place for human populations are not excluded from the occurrence of these natural disasters, and serious measures are needed to reduce the vulnerability of these settlements to natural disasters. Today, urban needs and housing demand and the migration of villagers to cities have caused excessive growth and expansion of the cities, especially in large cities. The inattention to the correct orientation of cities, as well as the lack of the required planning to prevent the unbridled growth of cities, has caused many problems for the immunity of the cities. This process has led cities to expand on major routes of faults or in the vicinity of rivers and river sides. This issue, by itself can cause the increase in the vulnerability and increase of the financial and death tolls caused by these events. The fact is that the reflections of human settlements against these natural disasters that cause catastrophe. In urban areas, the normal effects of natural disasters may not be so harmful, but when it comes to human communities and human knowledge, they become natural-technological crises, which include a combination of physical injuries and functional impairment (Parsi, 2012, p. 42).

Among the natural hazards and crises, earthquake is one of the most important risks affecting numerous countries throughout the year and is a factor in which the impact of its complications on human societies, has been remarkable throughout history, either on the basis of mortality or economic aspects. Given the advances in knowledge and technology, as well as the daily increasing population and the need for urban development, how to deal with natural disasters, and in particular earthquakes, requires a series of measures in the framework of urban planning. Regarding the unplanned nature of these events and the necessity of making the appropriate decisions and executing proportional operations, in order to reduce vulnerability and safety, the most effective and possibly the best option is management and planning in this regard (Zayari, 2006, p. 283).

Various factors, such as inappropriate land use, inappropriate construction and design of buildings and inefficient urban buildings and infrastructures, can increase the risk of human settlements (Tucker, 1994, pp. 1-10). Making the cities and human settlements safe against earthquake hazards should be sought at

levels beyond making the building resistant, and the most important of these levels is urbanization. City form, city texture, urban densities, urban infrastructures, communication networks, land use are among the determinants of how cities behave against earthquakes (Amini et al., 2010, p. 162). The city of Ahar is geologically located in the Alborz-Azerbaijan structural zone. The intensity and variety of tectonic activities in the Ahar region have led to the displacement in different parts of sedimentary and igneous rocks, as a result, has created faults in the region. The seismicity study of the range of about 1 degree in 1 degree of the earthquake focal point of the year 2012 shows that about 380 seismic events occurred in the last century, of which 19 cases has magnitude 5 and more than 5 Richter. These statistics indicate high seismicity in the Ahar region and around it (International Institute of Seismology and Earthquake Engineering Research, 2012).

The most significant seismic event of the region, two earthquakes with magnitudes of 2.6 and 6 (on the Richter scale) occurred on August 25, 07, 2012, and had more than 4826 aftershocks. According to an assessment done by the headquarters of the East Azerbaijan crisis management, the damage caused to the province for this earthquake was more than 10 thousand billion rials. The highest damage record was registered in Ahar city with 3 thousand and 169 billion rials.

In this regard, considering these cases and the increasing sensitivity to the earthquake phenomenon and its consequences, as well as due to the geographical location of the city of Ahar and its position between the mountains of Ghushadagh and Gharadagh and the existence of riversides and streams inside it, on the one hand, and neighborhood with many faults and being placed in the area of high vulnerability to natural disasters, on the other hand, it has been tried to examine this issue using the results of previous researches and presenting combinational components and new indexes. The approach of this paper is to evaluate and analyze the vulnerability of Ahar urban spaces against the earthquake crisis and tries to determine the vulnerability of urban spaces against earthquakes by examining the existing situation and its analysis.

1.2. Significance of the Study

Due to its geographical location, climatic conditions and geological conditions, Iran is considered as one of the countries in the world's natural disasters. Given the fact that Iran is on the Alp-Himalaya earthquake belt, the historical background of earthquakes in it indicates the probability of a severe earthquake in the future. According to published statistics, Iran is one of the 10 most bombing countries in the world in terms of incidents, of which 30 out of 40 unexpected natural disasters occur in Iran. Iran accounts for only 1 percent of the world's population, while six percent of the world's casualties belong to Iran (Zare, 2001, p. 13).

Most studies have been conducted on the reduction of the losses due to earthquake have been about the construction methods of the construction units to increase the resistance of the building against the earthquake, which is only part of the readiness aspects to deal with the earthquake. The assessment of the number of injuries and damages of earthquake in cities has shown that a high percentage of injuries have been directly related to the unfavorable situation of planning, identification and reduction of urban hazards and the need to make right decisions and implementing the projects proportional to it and also with regard to the advancement of human knowledge and technology, in order to provide a clear picture of the consequences of the hazards, the assessment of vulnerable urban areas is necessary. This assessment and planning in line with it is the most efficient or possibly the best option for urban management and planning to deal with natural hazards, and in particular earthquakes. Undoubtedly, urban development plannings, regardless of natural hazards such as earthquakes and other geological hazards such as mass movements, land subsidence, and so on ... are not possible. Meanwhile, the occurrence of earthquake is a serious threat to development, as it causes the long-term investment of emergency capital to be destroyed and the valuable resources of development are eliminated. Only by understanding the functioning way and behavior of earthquakes in urban areas and using appropriate strategies in different fields and conducting studies and actions such as land plotting, regional planning, urban planning and design, optimal design and making the structures resistant and ... so on it is possible to reduce the risk and damage caused by the earthquake.

2. Literature Review of the Research (Theoretical Foundations)

Urban space is part of the city's construction, which has a coherent and continuous presence and has an enclosure body in physical aspect. This space has has decent and beautiful order, and is organized for the city's activities. On the other hand, urban space is part of the living organism of the city, which is

associated with changing social, economic and technical conditions (Parsi, 2012, p. 43). All of the above categories will result in an affiliated population that will be heavily influenced by natural disasters and will lead to a breakdown of the life system and cause many losses of life and financial resources. Based on International Strategy for Disaster Reduction United Nations, all dangers have two sources: the natural hazards and risks of technology (man-made) or accidents resulting from human intervention ([Moe and Patharkul] 2006, p. 396) . A natural hazard is a natural phenomenon that occurs in the vicinity of human settlements and presents a threat to people, structures, or economic capitals, and may lead to a crisis (Iron, 2007, p. 5). Here it is worth mentioning that, in spite of the natural expression, a natural hazard has an element of human interference in itself.

A physical event, such as a volcanic eruption that has no effect on human life, is a natural phenomenon, not a natural hazard. In fact, an event is hazardous event or a natural hazard that occurs in a residential area, and if it leaves many financial and life losses, it is known as a natural disaster. By this definition, the origin of the event is changed from a completely natural process to the simultaneous presence of human activities and natural events (Zare, 2012). Earthquake as one of the most destructive natural phenomena is one of the most recognized natural disasters in the world due to the vast scope of its territory, the abundance of its occurrence, and the extent and severity of its imposing damages (Maleki 2007, p. 114). Evidence indicates that the earthquake threat in the urban areas has been expanding globally, and this threat with a rising trendis one problem among the problems of developing countries (Tucker, 1994, p. 10). Considering the increasing occurrence of natural disasters, especially earthquakes in recent years in different parts of the world, and consequently increase in the losses and damages caused by the occurrence of these phenomena, the issue of reducing injuries and damages caused by accidents and increasing resistance and readiness against them has become of particular importance. So that the 1990s was named as the International Decade for Disaster Reduction by the United Nations during which the studies and comprehensive research on knowing the cognitive effects of disasters in different parts of the world were conducted to reduce the damage caused by the accidents (Pourkermani and Arian, 2008, p. 42).

Vulnerability refers to the lack of sufficient capacity to deal with hazards based on the position of individuals and groups in the physical and social world. In other words, the vulnerability of the defined conditions is determined by the physical, social, economic and environmental factors and processes which increases the sensitivity and fragility of a society to the risks. Reducing vulnerability to natural hazards, promoting resilience and achieving sustainable development, in addition to recognizing the natural and spatial nature of the hazards, also requires a special recognition of the socio-spatial nature of vulnerability in societies (Ghadiri, 2010, p. 1). The characteristics and conditions governing urban spaces and the density of investment and environmental uploads have made it necessary to pay attention to the necessary planning for the protection of cities against these dilemmas and environmental problems. Urban vulnerability is the amount of damage that occurs in the event of an accident to a city and its components and elements in terms of their nature and quality. Analysis of urban vulnerability; analyzing, evaluating and predicting the probability of damages of life are material and spirituality of the city and residents of the city against possible risks (Ahadnezhad et al., 2011, p. 88).

The most important factors that are involved in increasing the vulnerability of the cities are: Urbanization, population growth, poverty development, cultural change, lack of awareness and lack of knowledge. The need to reduce the vulnerability of the city against earthquakes is considered as one of the main objectives of physical planning, urban planning and urban design (Ghanbari et al., 2011, p. 1). To this end, it is necessary to estimate the risking andthe damage based on various studies. In this regard, the possibility of assessing the effects of accidents based on the use of advanced and rapid methods can play an important role in optimizing risk management and crisis management(Mansouri and Amini Hosseini, 2007, p. 34). According to the following equation, vulnerability is directly related to the risk of earthquakes. In this regard, the risk aversion of earthquakes [Risk.], the risk of earthquakes [Hazard.] are human, political, social values and so on. Given the uncontrollability of earthquake hazard parameters and values, reducing vulnerability as a controllable parameter is of particular importance. (Zahraei, 2013, p. 23). In such a situation, the study of the issue of urban vulnerability and how it can be considered as a tool for more accurate planning before the occurrence of a disaster seems very necessary. For policy-making and planning the reduction of vulnerability of urban buildings to earthquakes and providing a clear picture of the possible occurrence of the earthquake and its consequences, it is necessary to evaluate the vulnerable areas of the city. Accordingly, today the situation and the various conditions before the occurrence of possible

earthquakes in different intensities are simulated and on the basis of which maps of vulnerability zoning of urban buildings are prepared and evaluated.

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Accordingly, today the situation and conditions before the occurrence of possible earthquakes in different intensities are simulated and on the basis of which maps of vulnerability zoning of urban buildings are prepared and evaluated.

Statistical Population (Spatial Area of Research):

3.1. Geographic Location

Ahar city with an area of 3074 square kilometers (6.7 percent of the area of Eastern Azerbaijan Province) is located 110 kilometers from Tabriz. The city has borders on the northern side with the cities of Horand and Kalibar, on the east side with Ardabil province, westward with the city of Varzaghan and from the south with Harris town. This city, as the center of Arasbaran region (Gharadagh) with 2404 km area and the population of 128111 people and 242 villages has been one of the most important cities of Azerbaijan during history. Ahar city is also one of the cities of Ahar city, which is the center of Ahar city (Yearbook, 2017, p. 1).

Also, according to the results of the general census of population of people and and housing in 2016, the population of Shahr is 154530 people.

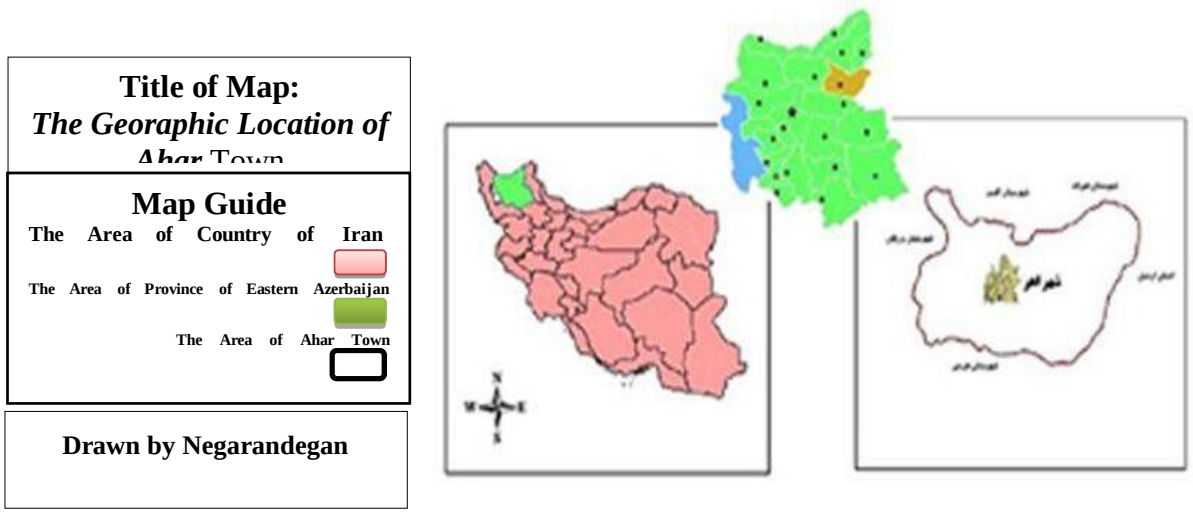

Figure 1. Geographic Location of Ahar City

Geology (Seismology) of Ahar

The city of Ahar is geologically located in the Alborz-Azarbaijan structural zone. The important feature of this zone is the high resemblance between the Precambrian, Cambrian and Ordovician facies with Central Iran. The intensity and variety of tectonic activities in the Ahar region have led to the displacement of different parts of sedimentary and igneous rocks, resulting in faults in the region. The main fault that causes the geomorphologic phenomena of the Ahar area is the northern fault of Ghushadagh (Dellalla Oghly, 2011, p. 7). In the city, there are many abrasions and fractures with the northwest-southeast trend, which can be related to the faults of Mazraeh, northern Ahar, Khomeideh and Neh Abad and the Kajan fault (Ranjbar and Rashidzadeh, 2011, p. 32).

The faultsouth of Ahar (Ghushadagh fault) is the largest fault in the Ahar region with approximate east-west orientation, with an approximate width of 200 meters and a length of 60 kilometers in the region. According to the earthquake hazard zoning map, the International Institute of Seismology and Earthquake Engineering, Arasbaran region is facing a moderate to high risk of earthquake.

The most significant seismic event that affected the Arasbaran area is two earthquakes of magnitude 6.2 and 6 on the Richter scale, which occurred on August 21, 2012, which had more than 4826 aftershocks. The first earthquake with a magnitude of 2.6 occurred at 16:53:15 local time, about 17 kilometers west of Ahar, occurred in the geographical coordinates of 4,385 degrees north latitude and 865.46 degrees east. The maximum recorded acceleration of this earthquake is recorded at 428 cm / squared second in the Varzaghan station by the Building and Housing Research Center.

The second earthquake with a distance of about 10 km with magnitude 6 on the Richter scale is registered in 28 km west of Ahar and 10 km of Varzaghan in the coordinates of 449.38 ° L and 731.46 ° eastern longitude at 17: 04: 34 and at the maximum recorded rate of this incident took at the Research and Housing Center at 534 cm / squared second, recorded at Varzaghan Station.

The center of both earthquakes is at a depth of about 10 km. Based on the observed damage to the instruments, the earthquake intensity at the Mercali scale is estimated in the Io = VIII clamping range. These earthquakes were felt in the provinces of Azerbaijan, Gilan, Zanjan, Ardabil and also in the Republic of Azerbaijan. According to official statistics, 306 people were killed and more than 2,500 people were injured as a result of this phenomenon. A total of 155,000 people, suffered from the accident among which 67,000, were in Ahar town (International Institute of Seismology and Earthquake Engineering, 2012).

Figure 2. Map of Earthquake Occurrence and its Influence Range in Arasbaran (2012) (Source: Geological Survey of 2012)

4. Research Method

The type of this research is in terms of applied purpose and research method is based on a descriptive-analytic method. The data have been obtained using library and office resources as well as field studies and surveys carried out in previous years. In order to express the vulnerability and determine its size and type, in this research due to data limitations, only a model is presented with consideration of some of these factors. Undoubtedly, in order to achieve a more effective model, all the effective concerned factors of attention can be identified. So far, analyses and assessments related to earthquake vulnerability have been used in about 8 to 10 indexes, but according to the results of previous studies, in this research, we have tried to combine past research methodology and use of 15 different indexes in the form of three spectra of natural indexes of planning and instruments, to analyze and assess the vulnerability of urban spaces of Ahar city against earthquake based on the model.

The term AHP stands for the Analytical Hierarchy process, meaning the hierarchical analysis process. The selection of the criterion or criteria is the first part of the AHP analysis. This method is one of the most widely used methods for ranking and determining the significance of factors, which uses a paired comparison of options to prioritize each criterion. If the options are high, the formation of a pair comparison matrix is a difficult task.]

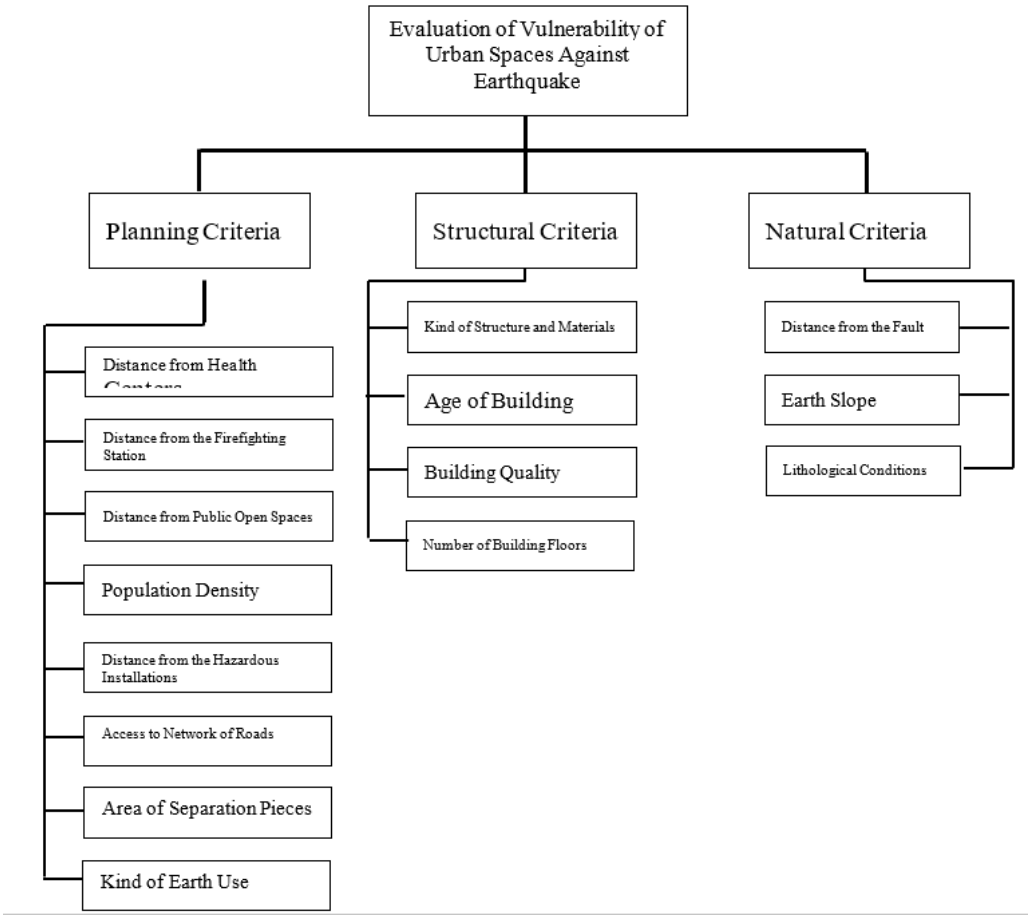

Figure 3. Hierarchical Model of Vulnerability Assessment Indicators of Urban Spaces

Using a simplified AHP hierarchical model, vulnerability has been investigated in five vulnerabilities, very low vulnerability, low vulnerability, moderate vulnerability, high vulnerability, and very high vulnerability.

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Research Findings

The results obtained from the weight extraction of each of the indexes that affect the vulnerability of urban spaces by AHP indicate the high importance of the kind of building materials, building quality, access to open spaces and the factor of distance from fault lines.

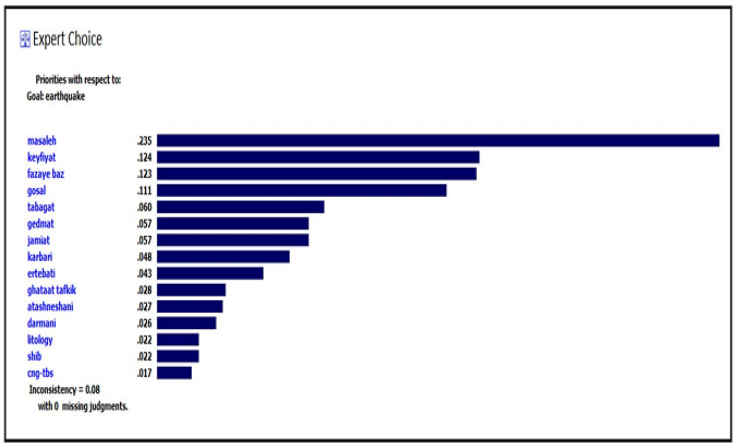

Figure 4. Calculated Weights by Expert Selection Software

In the final analysis, in this study, the city of Ahar has been classified in terms ofvulnerability to earthquake hazard in five areas: very high vulnerability, high vulnerability, moderate vulnerability, low vulnerability and very low vulnerability. In a general analysis, the results show that most of the built parts of the city are located in the middle vulnerability zone, so that parts of marginal neighborhoods in the area of high vulnerability; central parts, worn-out texture and historical in damage zones of and highly developed area, standardized and planned areas of the city are classified in the low vulnerability zone. However, in the zoning of the entire city's vulnerability, which includes built and arid spaces, the city is in a low vulnerability class. The results show that 63 percent of the overall urban spaces are very low vulnerable, 12 percent are low vulnerable, 17 percent are of average vulnerability, 5 percent are highly vulnerable, and 3 percent of the total urban spaces is very highly vulnerable.

Using vulnerability maps in a comprehensive view, it can be said that in Ahar, two types of texture are now identifiable and distinguishable: a) traditional and dense texture; b) new and discontinuous texture. These spaces are divided into four general parts: worn out and historic texture, marginalized areas with informal settlements, mid-town areas and planned marginal areas that are considered for the future development of the city, which have respectively a descending vulnerability pattern are in this category.

The results of the hierarchical analysis model show that most of the half western parts of the city are in the medium and medium to high vulnerability areas, which can be clearly seen by observing vulnerability maps.

6. Conclusion and Suggestions

6.1. Conclusion

The most important factors contributing to reinforcing urban vulnerability include urbanization, urban infrastructure deficiencies, population growth, the impact of institutional and political dimensions such as the problem of legislation and the lack of comprehensive urban planning policies, economic dimensions such as inadequate resources for management The dangers and the spread of poverty, and ultimately the socio-cultural dimension, such as cultural change, lack of awareness and lack of information.

2.6. Suggestions

1.2.6. General Suggestion:

In order to reduce the financial and financial losses of the earthquake, one of the most important measures is to observe the fault's privacy and, as far as possible, construction around faults should be avoided.

2.2.6. Applied Suggestions:

A) With regard to the city of Ahar, due to the existence of the active fault of Tabriz in the southwest of the city, it is suggested that the construction and development of the city will be from east and northeast. In terms of population density in the parts of Ahar, it is important to modernize these areas and to carefully evaluate the quality of construction as well as the principles of urban planning, such as the proper width of the alleys and streets in the reconstruction of such areas, for example, low-

lying and narrow communication paths which in case of destruction, will cause general obstruction should be corrected, as it will provide appropriate access (from the viewpoint of speed and safety) of all parts of the city to relief-therapeutic uses.

B) Construction of at least two fire stations in the northeast (Kargar-Shalilan Square) and south of the city (Bahram Abad) and the construction of at least two hospitals equipped to accept the injuredindividuals from the earthquake in the western regions (the old tower) and the central (Jolfa Lar) and it is recommended to create a park and green space in the western, eastern, and north-eastern suburbs of the city in order to shelter the inhabitants of these spaces during the earthquake.

C) On the other hand, neighborhoods with worn out buildings and buildings with sensitive applications and water transmission networks and power towers need to be redefined and should be considered. The lack of construction on the slopes and the slopes that have the potential for landslide is also important, and the construction of thatched and low-resistant houses in the villages should be avoided.

D) It is suggested that the city must have an intelligent system for the rapid disconnection of gas flow during an earthquake, and that networks and pipes for water should be rehabilitated and restored; construction of the Ahar Chay and Ketchik Chay rivers due to the possibility of damages Avoid potential flood events due to the closure of their paths, as well as downstream of the Sattar Dam due to the dangers caused by the failure of the dam.

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